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PHYSICAL ANTHROPOLOGY AND ITS AIMS[1]

THE phenomena of the universe, brought within the range of human understanding and preserved in memory or writing, constitute knowledge; and systematic search for knowledge, on the basis of the highest standards of learning, is science. This in its application being of the utmost utility, constitutes the most important function of mankind. A branch of science is a portion of systematic research that extends to closely related phenomena and has become the special function of a definite class of qualified observers.

One of these branches is anthropology, described by its principal promoter, Broca, as "the natural history of the genus *homo*," or, more in detail, as "that science which has for its object the study of mankind as a whole, in its parts, and in its relation with the rest of nature."[2] In the light of to-day, it may be defined more strictly as that portion of systematic research which deals with the differences

[1] Annual address of the president of the Anthropological Society of Washington, given under the auspices of the Washington Academy of Sciences, February 11, 1908.

[2] Article "Anthropologie" in the Diction. encyclop. d. sc's. méd., Vol. V., p. 276—Paris, 1866; also in Broca's "Mémoires d'anthropologie," Paris, 1871, Vol. I., p. 1. References to numerous definitions in R. Martin, "System d. (physischen) Anthropologie, etc.," *Korr.-Bl. d. deutsch. Anthrop. Ges.*, 1907, Nr. 9/12. See also L. Manouvrier, *Rev. de l'École d'Anthrop.*, 1904, pp. 397–410, and F. Boas, "Anthropology," 8°, pp. 1–28, The Columbia University Press, N. Y., 1908.

in structure, in function, and in all other manifestations of mankind, according to time, variety, place and condition. It is the science of structural, functional and cultural differences in mankind in its epochs and its groups. That part of the science which occupies itself with the body and its functions, investigating their differences, causes, modes of development and tendencies, from man's beginning, and among his present multiple groups—the research, in brief, into man's organic and functional variations—is physical anthropology.

The comparative element is the fundamental characteristic of anthropology and that which distinguishes it from allied branches of research. It shows clearly the position of physical anthropology in relation to general human anatomy and physiology, and towards general biology. The main objects of general human anatomy and physiology are the completion of knowledge regarding structure, and its inseparable functions, in the average man of the present day; while the chief aims of general biology are to trace the structural and functional relations of the different species of living beings to one another, and search for the causes and processes of organic variation and evolution. Physical anthropology is a continuation, an extension, of all these, to the epochal, racial, other natural, social and even pathological groupings of mankind, and reaches with its investigations beyond man only so far as is necessary for understanding the phenomena which it encounters. If it had not its present designation it could well be called "advanced human anatomy and biology."

Physical anthropology is still a young branch of science, though its roots lie far back in the development of human reflection. It is interesting to know that the discovery of America, with its new race of people, was one of the main incentives to research in this line. This was followed by discoveries of other lands and peoples in the Pacific and by slowly increasing knowledge of organized beings in general, including the anthropoid apes. All this aroused new thoughts in scientific men and doubts as to the correctness of the old theories of creation; and the fermentation in minds, though greatly impeded by the power of dogma, progressed until it finally began to pierce the cloud and manifest itself in publications. Peyrere's "Preadamites" appeared in 1655, and, notwithstanding prohibitions and the small real worth of the book, was received with eagerness and read very extensively. In 1699 was published Tyson's "Comparative Anatomy of Man and Monkey." And in 1735 we see the actual foundation stone of modern anthropology laid by Linnæus. It was in Linnæus's "Systema Naturæ" that man for the first time was placed in, instead of outside, the line of living beings in general, and that his close organic relation with the rest of the primates was authoritatively expressed. Then came Buffon, with whom the new branch of the natural science of man takes a more definite form, and thence the progress towards anthropology, as differentiated to-day, is continuous. The men who contributed towards its development are too numerous to mention; they include all the prominent naturalists and anatomists of the latter half of the eighteenth and the first half of the nineteenth century, such as Camper, Lamarck, Blumenbach, Soemmering, Lacépéde, Cuvier, Retzius, the brothers Geoffroy, Morton, Lawrence, Edwards, Serres, Pritchard and many others.[3] Even the teachings of

[3] For details concerning the history of anthropology see T. Bendyshe, *Mem. Anthrop. Soc. London*, Vol. I., 1863–4, pp. 335–458; P. Topinard's "Elements d'Anthropologie générale," Paris, 1885, pp. 1–148; L. Niederle, *Athenæum*, Prague,

Gall, however erroneous in application, have assisted its growth, for they stimulated research regarding the variations of the head, skull and brain, and were the main incentive to Morton's remarkable work "Crania Americana." And the discussions of the mono- and polygenists, particularly those of the nineteenth century, were of great importance in this connection.

The first effort at some organization of forces in the new line was made as early as 1800, when a small body of scientific men formed themselves, in Paris, into a Society of Students of Man (Société des observateurs de l'homme). It was in this little circle that the term anthropology (used previously as a title for some works on man of philosophical and in a few instances of simple anatomical nature) was employed in something like its present significance. This attempt at organization was, however, premature and had to be given up two years later (1803), after but little had been accomplished. In 1832 the Paris Museum of Natural History, under the influence of Professor William Edwards, transformed its chair of anatomy into that of natural history of man, and to this Serres, in 1839, added anthropology; but the time was still not ripe for the subject to assume much importance. From 1839 to 1848 Paris had a Society of Ethnology, which included the physical branch, again with but little result. It was not until the commencement of the second half of the nineteenth century, with the advent of Paul Broca and his collaborators, and the foundation of the Paris "Société d'anthropologie" (1859), that the actual birth of the new branch of science took place. This is less than fifty years ago; and how difficult the beginnings were even then will be appreciated from the following recently published[4] details. When permission to establish the society was sought, the minister of public instruction, notwithstanding the rank and fame of the men who with Broca applied for the sanction, refused to have anything to do with the matter. He sent the petition to the prefect of police, but the prefect was equally unwilling and returned the document to the ministry as he received it. It was not until after the influential intervention of Ambroise Tardieu, that one of the chiefs of the police department was persuaded the scientific gentlemen in question were not quite as dangerous to the welfare of the empire or society as was suspected, and not finding, besides, any law that forbade the gathering of less than twenty persons, he informed the eighteen future anthropologists that their meetings would be tolerated. But Broca was made responsible for anything that might be said at the meetings against the government or religion, and every meeting was to be attended by a plainly dressed officer.

From the establishment of the Société d'anthropologie the progress of the new branch of research was more rapid. Before long similar societies were organized in England, Germany and other countries; the publication of anthropological journals was commenced; an efficient system of anthropometry, with the required instruments, was devised, principally by Broca, and detailed instructions in the system were published by the same author; collections and important lines of research were begun in different parts of Europe and also in the United States; and in 1876 was founded the Paris School of

1889 (repr. pp. 1–19); F. Boas, SCIENCE, Oct. 21, 1904, pp. 513–524; references to more or less direct contributions to the subject in R. Martin, o. c.; and the "Recent Progress in American Anthropology," *Am. Anthrop.*, Vol. 8, No. 3, 1906, pp. 441–556.

[4] "L'Ecole d'Anthropologie de Paris," 1876–1906, 8vo, Paris (F. Alcan), 1907.

Anthropology, for academic instruction and training in the new branch of science. Finally, in 1885, appeared Paul Topinard's great text-book on anthropology, the "Éléments d'anthropologie générale," which to this day is an indispensable volume in our laboratories. A long step was made during this time in the differentiation of anthropology as a whole into its main subdivisions, namely, physical anthropology, ethnology and archeology.

But this period of the first twenty-five years of anthropology as a separate branch of learning, a period of the greatest activity, the detailed and still unwritten history of which is of absorbing interest, was not one of uninterrupted progress. There was encountered, above all, a crisis which affected especially physical anthropology and from the effects of which it is only now beginning to recover. This crisis was the result of what may be called a schism in anthropometry, begun in 1874 by Ihering and completed in 1882 by the German anthropologists at Frankfurt. This is not the place for a discussion of the causes or details of the case; it suffices to say that at the present time a commission, composed of the foremost physical anthropologists of Europe—French, German and from other countries—is endeavoring, and with much success, to select the best from the existing methods in anthropometry and bring about a much-needed uniformity.[5] A complete agreement on this subject will be of the greatest importance and mark an epoch in our branch of learning.

This chapter, necessarily superficial, will be appropriately concluded with a few words concerning the actual status of physical anthropology. The subject, like the whole history of this science, calls for a thorough presentation, but such is out of the question in an address of this nature.

Physical anthropology counts distinguished followers wherever science progresses; it has already an extensive bibliography of its own; it maintains a number of well-equipped laboratories, where students are trained; it possesses a large series of important collections of material for investigation; it contributes the bulk of original matter to well-established anthropological journals of high standing, such as the *Bulletins et Mémoires de la Société d'anthropologie de Paris,* the *Archiv für Anthropologie,* the *Zeitschrift für Morphologie und Anthropologie, Biometrica, Man,* etc., while numerous other results of investigation are being disseminated through periodicals devoted to anatomy, general biology, and to other subdivisions of anthropology; finally, it is a subject or a part of instruction in the École d'anthropologie, in the Anthropological Institute of Zurich University, in several large museums, and in one or more of the principal universities in almost all civilized countries.[6] It is still struggling with numerous difficulties which retard it, but, unless development in science stops, it has before it a wide and useful future.

II

The questions are often asked by those

[5] For what has been accomplished see F. v. Luschan, "Die Konferenz von Monaco," *Korr.-Bl. d. d. Ges. f. Anthrop., etc.,* Juli, 1906, pp. 53 et seq.—in *Arch. f. Anthrop.,* 1906, H. 1–2; and "Entente internationale pour l'unification des mesures craniométriques et céphalométriques," *L'Anthropologie,* 1906, pp. 559–572.

[6] For information regarding instruction in anthropology see J. Ranke, in Lexis, 1896, p. 117; W. Waldeyer, *Korr.-Bl. d. d. Ges. f. Anthrop., etc.,* 1896, p. 70; G. G. MacCurdy, Science, Dec. 22, 1899, and Feb. 7, 1902; "Recent Progress in Anthropology" (a review of the activities of American institutions and individuals from 1902 to 1906), *Amer. Anthropol.,* Vol. 8, No. 3, 1906; R. Verneau, *Bull. et Mém. Soc. d'Anthrop. de Paris,* 1902, p. 12, and *l'Anthropologie,* 1904, pp. 113, 252 and 483.

whose preoccupations have not permitted closer following of this branch of research, what has physical anthropology accomplished, and what are its aims for the future. Both of these are weighty questions and deserve to be answered.

The amount of work actually done must be considered, together with the obstacles that have stood in the way of fruitful investigation. The greatest of these obstacles has been the imperfect state of anatomical knowledge, which is the starting point of physical anthropology. It is obvious that structural comparison, extending to various groups of humanity, can properly be carried on only on the basis of a thorough knowledge of structure in some one type of man, preferably the white race. Had anatomy been able to furnish such a foundation to physical anthropology, the progress of the latter would have been immeasurably easier and more rapid. As it was, the new branch began to differentiate itself while general human anatomy was yet very imperfect, and in consequence it was confronted with the tedious task of establishing or improving the basis for its future comparisons. Thus a large portion of the work of anthropologists became and still is purely anatomical. It is safe to say that fifty years ago, when the Paris society of anthropology was founded, there was not one point in any part of the human organism that was well known and understood. Even at this day, with all the excellent work accomplished, there is not yet a single bone in the body, and perhaps no other organ, the knowledge of which together with that of its total range of variation is perfect, and that even in the white race alone, which has been most studied. The splendid anatomical text-books of the day give little more than generalities. The specialized literature is much richer; but when one comes to details, there are innumerable lacunæ. Yet details are to-day the essentials of all research, and they are indispensable in anthropological comparisons. It would almost seem from this that the birth of physical anthropology had been premature; but if one stops to consider the deep interest its problems have for humanity, it is seen that its early rise, even on the but partly prepared soil, was natural.

The second great obstacle to the progress of physical anthropology has been the defects in collections of needed material. The third was the dearth of properly trained men, and in the fourth place should be named the difficulties, based on various prejudices or want of comprehension, attending the collection of accurate anthropological data in many parts of the uncivilized and even the civilized world. Still further impediments, attending this more than other branches of natural science, were those accompanying the elaboration of the necessarily extensive series of data and especially their publication.

With regard to material, what collections of value for physical anthropology were there half a century ago? Fair beginnings had been made by that time in a number of the European cities, and one particularly interesting one on this continent—that of Morton in Philadelphia; but all this was limited to crania and was useful in awakening suggestions rather than leading to definite conclusions. It required years of assiduous collection and excavation before actual scientific work of any extent could anywhere be attempted. Such collection has been going on, and there are now several great and many minor gatherings of identified material, including those in the National and other American museums. Yet even now we are far from the ideal in this direction, or from collections which would include at least the bones of the whole skeleton, and the brain, and enable us to determine the complete range

of variation in these parts of special importance in at least the most significant groups of humanity. What is required in this line will be clearer when it is appreciated that, to determine the total range of variation in a single long bone, such as, for instance, the humerus, in any particular group to be studied, there are needed the remains of hundreds of individuals of one sex from that group. As it is, even the greatest collections fall still far short of the requirements, and the investigations carried on with them can be seldom perfect or final.

The dearth of properly trained men has been a great hindrance in physical anthropology. The cause of this is simple enough. The branch demands extensive preparation and arduous work, for which it offers at best only moderate pecuniary reward. It has not yet reached the stage of its ultimate public utility and in consequence receives much less public recognition than the so-called applied sciences. Under these circumstances the recruiting of regular workers of the right class is precarious, a new physical anthropologist is almost an accident and the supply of students is far short of what is needed.

The difficulties of gathering the requisite material, and even the data alone, have been infinite and are still very great; in fact they are sometimes quite insurmountable. Religious beliefs and superstition, but also love, cover the dead body everywhere with a sacredness or awe, which no man is willingly permitted to disturb. It is not appreciated that the secured remains are guarded in the laboratory with the utmost care and for the most worthy ends, including the benefit of the living. The minds of the friends are only apprehensive of mutilation and sacrilege, or simply fear the disturbance. These conditions extend with small exceptions to the civilized and savage alike, and to collect, in their presence, large supplies of material indispensable to physical anthropology is often very arduous and unsatisfactory. The impediment that this constitutes to the advance of the science is beyond computation. And the difficulties extend even to the data on the living. The stumbling blocks due to ignorance and superstition are particularly numerous in the way of measuring, and are met with even among the otherwise most enlightened. Compare with this the facilities of the zoologist or botanist!

Notwithstanding these and other obstacles, among others those placed in its way by the ill-fitted or fool investigator, physical anthropology has already accomplished considerable useful work. It has established a system of precise measuring of man and his remains, and has furnished the needed instruments; it has directly advanced general anatomy, particularly that of the skeletal system and brain of man and other primates, and contributed to zoology, general biology and other natural sciences; it has established the physical knowledge of the races and many of their subdivisions, and has aided through its activities the advance of its sister branches, ethnology and archeology; it has given a far-reaching impetus to search for the remains of early man, and has determined the physical characteristics of the finds made; it has actuated and to a large extent carried out the study of man's development from his inception onward; it has brought about physical investigation and through tnis a vast improvement in our knowledge of the criminal and other defective classes; it has led directly to the practical systems of identification of criminals; it has taken part in and promoted the studies in human heredity, variation, degeneration and hybridity; it has added to knowledge of the functions and pathology of the human body and

especially of the brain; it has furthered vital statistics; and it has already begun to assist other branches in pointing out, on the basis of gained knowledge, ways towards the safeguarding and improving of the human race. This outline is necessarily defective, yet it will show that physical anthropology, notwithstanding the many and great obstacles in its road, has justified its separate existence, and the decrees by which the French government pronounced it, in 1864 and again in 1889, as a science of public utility.

III

The object of the final chapter of this address is to outline in a brief way, and yet not too generally, the future field and aims, in a word the future program—as it appears to the speaker—of physical anthropology. Could such a program be perfected, it would itself mean an important step forward.[7]

The future activities of physical anthropology must extend to its own body and means, as well as to further research work proper; the more extensive and efficient the former, the more important and prompt will be the scientific results.

The main needs—which logically become the aims—of the anthropologists themselves, include more regular and extended recruiting of their ranks; a closer general unity and cooperation; definite unification and perfection of anthropometry in its whole range; systematization of the methods of treating and recording of data; the supply of fresh text-books, and advance towards strictly specialized periodicals; the compilation of a complete bibliography relating to this branch of research, and its continuation; the generalizing of information concerning collections of material; and the augmentation and improvement of collections.

Recruiting with the right kind of men is very urgent. It conditions further development of academic instruction and laboratory training; it makes very desirable the extension of lectures on physical anthropology to medical colleges; but, above all, it necessitates financial resources from which scholarships could be offered to men to be trained in the laboratory and in the field, and an improvement in the prospects of their employment with fair compensation after their preparatory studies and training have been completed. The time required for the proper training of the physical anthropologist, coupled with that needed for the acquisition of indispensable experience, extends over several years of post-graduate activity, and as the men who are best prepared for such training and most likely to be interested are those who have completed a medical course, these years of specialized training and work mean a real pecuniary loss, which ought to be at least partly indemnified. Until provision is made in this point it can not be expected that the requisite numbers of students will be attracted to and will specialize in physical anthropology. And this applies particularly to this country, where the prospects of the graduate in medicine—as well as in other sciences—are brighter than in many parts of the old world. The most suitable means of compensation during the preparatory years would be scholarships, continued with the right kind of men until they find positions. The opportunities of employment for well-trained anthropologists are not so few as one might be led to believe; the principal problem is to augment the compensation, so that it may correspond better to the needed preparation and with the prospects of a man as well trained, had he followed

[7] See in this connection, and for further references to literature on this subject, R. Martin's above cited paper on the "System of Physical Anthropology and Anthropological Bibliography."

another vocation, such as that of the physician.

Closer unity and cooperation among physical anthropologists of different countries must always be one of our cherished aims, and the same is true of the unification and perfection of anthropometrical processes and standards, as well as the methods of dealing with anthropometric data and their recording. Concerning the latter, the establishment of definite rules is still distant, the whole subject being in the process of evolution. One of the main questions, accentuated especially since the establishment of the journal *Biometrica*, relates to the employment and utility of higher mathematics in the analysis and presentation of the data. A simple exposition of facts, intelligible to every educated person, carries with it so great an advantage to every branch of investigation and to the public as well, that the matter of the extensive use of algebraic formulæ in publication can not be passed over lightly. It would be folly to oppose the legitimate use of higher mathematics, which in special cases excel all other methods, and may, in fact, be the only means by which to arrive at a solution of a given problem; but when it comes to the presentation of the results arrived at, it can not be denied that the high-mathematical method, while finding special favor with some, abstracts the subject from critical perusal by a large percentage of scientific men, not to speak of others. The whole matter demands very careful attention.

A supply of up-to-date text-books is a pressing need. It was twenty years ago that Topinard's great handbook appeared and nothing has been produced since that would bring it up to date or replace it. Yet a considerable advance has been made in every direction and the need of a thorough presentation of the accumulated facts and changes is acute. There is hope that the unification and precision of anthropometric methods, inaugurated two years ago at the Congress of Monaco, will stimulate efforts in this direction.

An advance towards strictly specialized periodicals, to be devoted exclusively to physical anthropology, is merely an aim at a further step in differentiation, such as is manifested in all other branches of research, after they have reached a certain stage of development. It depends upon the strengthening of the ranks of the physical anthropologists.

The importance of complete and continued bibliographical record is evident enough to every student and author and is an aim calling for the earliest possible realization. Beginnings in this line have already been made, particularly with current literature, and more is promised, but the movement calls for definite organization and extension to the older publications.

Improvement in and generalization of information concerning collections in physical anthropology are highly desirable. Such information, furnished through periodically supplemented registers of material by and to all institutions, would greatly promote collaboration as well as the extent of research. An additional procedure of much consequence would be the deposit of smaller collections in larger centers in each country, where they could be better cared for and be more available.

Finally, a matter of vital concern to physical anthropology is the augmentation and improvement of its collections. It is necessary that these be supplemented in a more systematic manner than has been done hitherto, and in all particulars. There are needed much additional osseous material, including all parts of the skeleton, for racial and other group studies; ample developmental series, on which could be determined racial and other peculiarities

in all stages of growth; the largest possible acquisitions of skeletal remains from all the periods of peoples known the longest to history, such as the Egyptians, the Semites, the Chinese, for the ascertainment of physical variations in different localities in known time; large collections of brains, preserved by uniform methods, for the study of gross, minute and chemical differences in that organ, in definite groups of humanity; and substantial series of at least the skeletal parts and brains of the anthropoid and other apes, for purposes of comparison. The existing material, as well as that to be added, should be held in the best possible condition regarding identification, cleaning, repairs and preservation. All these are conditions, on the fulfilment of which further advance in physical anthropology depends directly. Other objects needed, at least in our great museums, are series of specimens fit for exhibition, for illustrating to the public the most interesting human variations; and large gatherings of good photographs, as well as accurate casts, fit for both study and exhibition.

The above by no means exhausts what may be termed the internal wants and therefore aims of physical anthropology. There still remain the very important objects, of the virile development and advance of teaching; the highest of our hopes, namely, the foundation of separate central institutes of physical anthropology, like the École d'anthropologie; the forming of a special, international association; the conservation of original, detailed data, etc. But these are largely matters of development of the branch, dependent on progress realized in the points before specified, and their discussion can be postponed.

This leads to the scientific aims proper of physical anthropology, and these are innumerable. They extend from questions of pure science and natural philosophy to those of high practical utility, and from those of local interests to those of all humanity. I shall pass briefly over those of a more general nature and conclude with those that are more specially American.

The most urgent and important scientific object before physical anthropology is the gradual completion—in collaboration with anatomists, physiologists, and even the chemists—of the study of the normal white man living under average conditions, and of the complete range of his variations—these facts to form a solid and sufficient basis for all comparisons. This goal is still very distant, notwithstanding the mass of work already accomplished. It is necessary to renew and extend the investigations on every feature, every organ, every function of the medium white man, until these are known in every detail. The facility and value of all comparative work will increase in direct proportion to the degree of the consummation of efforts in this direction. The choice of the white man for the standard is merely a matter of convenience; the yellow-brown or black man would do equally as well, if not better, were he available.

The second task of physical anthropology is to perfect, or aid in perfecting, detailed knowledge of the structure, function and chemical composition—with their variations—in the primates. This field of investigation may be regarded as the vestibule to the space occupied by man's natural history and is indispensable to the understanding of man's past and continued evolution, collectively and in every particular. The fossil forms of the primates must naturally be comprised with the living.

The third great duty of our science is the determination of development and variation in man's structure, and also as far as possible in other organic qualities—particularly those of chemical nature—in rela-

tion to time. This comprises a delicate and thorough study of every specimen of man of geological, and ample series of those of historical, antiquity. Research as to the bones of the geologically early man has been painstaking, but the specimens themselves are still very limited in number and imperfect; while the study of man's variations within the time of which there is closer and finally historical knowledge, is still in its infancy. The investigations here mentioned relate principally to the important phase of man's evolution as man.

The fourth leading object of physical anthropology is the study of the human races and their subdivisions. This subject has attracted attention since the earliest time, and contributions to the theme are numerous as well as important; yet the road to go is still much longer than that already traveled. The very term "race" awaits as yet a definition that would be universally adopted. There are still immense territories in Asia, Africa, Oceania and America, concerning the populations of which our knowledge is very rudimentary, or wholly deficient; and the subdivisions of the white race still offer a vast field for further investigation. The appreciation of what remains to be done on the races and tribes of man impresses one forcibly with the fact that we are still only in the beginnings of this study and barely emerging from empiricism. The future work in this special field must be more extensive, systematized and critical.

Directly connected with racial studies, but of more serious concern to many nations, are investigations into the effects on the progeny, physical and potential, of racial mixtures. Mixture of races is a matter which can be brought largely under control through law and through general enlightenment. In view of this, a precise knowledge on the subject is a necessity, and to furnish it must be one of the main aims of anthropology.

Next in sequence, but not in importance, are studies concerning the numerous environmental groups of humanity—of groups developed and continuing under extremes of elevation, climate and nourishment; or under the greatest specializations in clothing, food, occupation or habits that are liable to permanently affect the body or its functions. All such conditions are followed by functional and structural accommodations of the system, and it is to be determined how they eventually affect the progeny. Learning the exact facts in these lines is beset with great difficulties, but the results are bound to be of much practical, as well as scientific, utility.

A still further extension of the studies takes up the pathological groups of mankind, including the alcoholics, epileptics, insane, idiots, perverts and other defectives or degenerates, and also criminals. This part of anthropological research is already well advanced and has, with the help of medical men, accomplished much of immediate benefit to society. But the aims of scientific work in this direction, a complete knowledge of these classes, are yet far from having been attained. Their realization depends to a very large extent upon the perfect understanding of the normal contingent of the human family.

Somewhat separate from all the preceding are studies in human ontogeny, or the development of the individual from birth onward, in all divisions of mankind and under all specific conditions. The contributions to knowledge in this line have already been substantial, though almost restricted to the whites. One of the most interesting parts of this study will be that of man's decline in the different races and under various definite conditions.

Finally, the ultimate aim of physical anthropology is to show, on the basis of

accumulated knowledge, and together with other branches of research, the tendencies of the future evolution of man and lay down indications for its possible regulation or improvement.

A few words in conclusion regarding the duties of physical anthropology in this country and in America in general. American students ought to contribute, as much as lies in their power, to knowledge concerning the white race at large and of other peoples outside of this continent with its dependencies. They have already added in no small degree to the study of child growth and should not stop in this direction; they should also cooperate in all investigations concerning special, environmental and pathological, groups of humanity. But there are several problems which will be to them of especial importance and demand the bulk of their labor. These are: (1) The appearance of man in America; (2) the composition and detailed characteristics, with their complete range of variation, and the affinities, of the indigenous race, including the Eskimo; (3) the crystallization of the new contingents of the white race in America, particularly in the United States; (4) the development of the negro element, especially in this country; and (5) the effects of the mixture of the white with the negro and the Indian. Beside these range themselves parallel problems affecting the insular possessions of the United States. All these are scientifically, as well as practically, serious questions, and research into them deserves to be generally promoted. There is no other branch of natural science which can occupy itself with them and define them; they are the rôle of physical anthropology in this country and demand its development.

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U. S. NATIONAL MUSEUM

THE HANOVER MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE special summer meeting of the American Association for the Advancement of Science held at Hanover, N. H., on the invitation of Dartmouth College, from June 29 to July 2, took place in accordance with the program that has already been printed in SCIENCE. The local committee, with Dean Robert Fletcher as chairman and Professor H. H. Horne as secretary, had made admirable arrangements for the reception and entertainment of members, and the college campus and buildings and the beautiful surrounding country were of even greater interest than had been anticipated.

The meeting was called to order at 8 P.M. on June 29 in the auditorium of Dartmouth Hall, and an address of welcome was given by the acting president of the college, Dr. John King Lord, who drew attention to the large place science now has in the college curriculum as compared with the conditions when the college was founded some one hundred and forty years ago. The president of the association, Dr. T. C. Chamberlin, of the University of Chicago, responded on behalf of the association and the visiting members. He laid stress on the increasing use of the scientific method in all subjects included in the college course and the importance of this movement for the future of society.

On Tuesday and Wednesday, June 30 and July 1, Section B and Section E of the association held sessions for the reading of scientific papers in conjunction with the American Physical Society and the Geological Society of America. Reports of the proceedings will be published subsequently in this journal. On the evening of June 30, Professor J. W. Spencer gave a public lecture entitled "The Spoliation of Niagara," and on July 1 Mr. J. S. Palmer lectured on "The American

Bison.'' On the following day, there was a general excursion to the Blue Mountain Forest Park, established by the late Mr. Austin Corbin to preserve the buffalo, moose, elk and other large animals of the American wilderness now threatened with extinction. Before, during and after the meeting there were excursions of much interest, arranged by the sections of geology and geography. An account of these will be published later.

The committee on policy of the association held a meeting with Messrs. Woodward, Chamberlin, Britton, Cattell, Nichols and Howard in attendance. In view of the facts that only two sections met at Hanover and that the attendance was small, it was decided that all business for the council should be postponed to the Baltimore meeting. It was announced, however, that Professor John Dewey, of Columbia University, had been elected chairman of the Section of Education; that the American Medical Association, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers will hereafter be represented on the council of the association; that the membership of the association now exceeds 6,000, and that progress had been made in the arrangements for a meeting in Hawaii in the summer of 1910. As the permanent secretary wishes to know who is likely to attend this meeting, the letter from the Hawaiian committee is printed here.

Hawaii Committee
1910 Convention
American Association
For the Advancement of Science.
Governor W. F. Frear, *Chairman.*
A. F. Griffiths, *Vice-Chairman.*
A. F. Judd, *Secretary.*

Honolulu, T. H.,
June 12, 08.

Dr. L. O. Howard, *Secretary,*
American Association for the
Advancement of Science.
Hanover, N. H.

Dear Sir: At a meeting called by Acting Governor E. A. Mott-Smith at the Governor's office to consider your letter in reference to the invitation of the American Association for the Advancement of Science to hold its convention, summer meeting, in 1910 in Hawaii, the invitation was cordially endorsed. The expressions of opinion left no doubt that the Association would receive a hearty welcome in Hawaii.

The following resolutions were adopted:

Resolved, That it is the sense of this meeting that a reply to the letter of Dr. L. O. Howard, Permanent Secretary of the American Association for the Advancement of Science, dated May 12, 1908, stating that an invitation had been received for the Association to hold a meeting in Hawaii in the summer of 1910, which invitation had been tentatively accepted, "provided suitable arrangements can be made," and wherein he asks certain questions, be replied to, as follows:

First. That the invitation to the Association to come to Hawaii is one which the people of the Islands generally and heartily approve.

Second. That the Association will be more than welcome.

Third. That the committees on reception and arrangements can and will be formed, consisting of the leading people of the Territory; that it is our belief that special expressions to this effect will be formally adopted at an early date by all the leading scientific, educational, commercial, political and social organizations in Hawaii.

Fourth. That entertainment at Honolulu will be furnished free to a large proportion of the members of the Association, and at greatly reduced rates to the remainder of them.

Fifth. That the question of transportation offers the greatest problem in connection with the invitation. As to this point, it is the belief of this meeting that the problem can be solved satisfactorily.

An organization was at once effected which will do everything possible to bring the Association to Hawaii and to provide for the entertainment of members who come. The list of the members of this representative organization follows:

W. F. Frear, Governor of Hawaii, *Chairman.*
A. F. Griffiths, President of the Trustees of the Oahu College, *Vice-Chairman.*
A. F. Judd, lawyer, *Secretary.*
E. A. Mott-Smith, Secretary of Hawaii.
Jared G. Smith, Director Hawaii Experiment Station.
F. L. Waldron, commission merchant, Chairman Hawaii Promotion Committee.
C. S. Holloway, Engineer, President and Execu-

tive Officer, Board of Commissioners of Agriculture and Forestry.
P. L. Horne, President, Kamehameha Schools.
D. L. Van Dine, Entomologist, Hawaii Experiment Station.
C. F. Eckhart, Chemist, Hawaiian Sugar Planters' Experiment Station.
S. B. Dole, U. S. District Judge, Ex-Governor, etc.
R. A. Duncan, Territorial Food Commissioner.
W. T. Brigham, Director Bernice P. Bishop Museum.
W. R. Brinkerhoff, U. S. Public Health and Marine Hospital Service.
H. R. Trent, President, Trent Trust Company.
L. A. Thurston, lawyer.
W. A. Bryan, President, Pacific Scientific Institute.
J. E. Higgins, Hawaii Experiment Station.
F. G. Krauss, Hawaii Experiment Station.
L. Lewton-Brain, Hawaii Sugar Planters' Experiment Station.
R. S. Hosmer, Territorial Forester.
A. Gartley, Manager, Hawaiian Electric Company, Regent College of Hawaii, etc.

This organization will include later many others who will join in the welcome and entertainment of the Association.

The officers are Governor Walter F. Frear, Chairman; A. F. Griffiths, Vice-Chairman; A. F. Judd, Secretary.

I send you herewith copies of resolutions and letters from practically all the scientific, educational, social and commercial organizations in the city whose assurances of good-will and support fairly voice the unanimous feelings of the community.

The generous offer of the Trustees of the Oahu College of the free use of the College Halls for the meetings of the Association and its sections assure the Committee of satisfactory and adequate places in which to hold the meetings of the convention. The satisfactory entertainment of the members is certain. Many will receive invitations to be guests in private homes. Many may prefer to live in the College Dormitories. The hotel accommodations of the city in addition are admirable.

The question of cheap transportation has already been taken up by the Committee. In this matter, we shall wish and shall need your cooperation as well as that of the other officers and members of the Association. The Committee is sanguine that a fairly good rate can be secured.

We hope that the advantages as well as the pleasure of holding the convention in Hawaii will be brought out in both the Hanover and Baltimore meetings. We are now preparing a statement of the unusual opportunities for scientific study that Hawaii offers. We shall have this ready for your use at an early date.

Assuring you that Hawaii will royally welcome and entertain as many members as can come to the 1910 convention, we remain,

Very truly yours,

(Sgd.) A. F. JUDD,
Secretary

A. F. GRIFFITHS,
Vice-Chairman

SCIENTIFIC NOTES AND NEWS

AT the centenary celebration of the founding of the Vienna Physico-Medical Society on June 27, Dr. Charles Sedgwick Minot, Stillman professor of comparative anatomy in the medical school of Harvard University, and Dr. Jacques Loeb, professor of physiology in the University of California, were elected corresponding members.

ON commencement day at Mount Union College, Alliance, Ohio, the degree of doctor of laws was conferred on President Charles Sumner Howe, of the Case School of Applied Science.

ON the occasion of the installation of Lord Rayleigh as chancellor of the University of Cambridge, the degree of doctor of laws was conferred on the following men of science: The Hon. C. A. Parsons, Sir Andrew Noble, Sir William Crookes, Professor H. Lamb and Professor George Downing Liveing.

PROFESSOR GRASSI, eminent for his work on malaria and other subjects, has been created a senator of the kingdom of Italy.

DR. JOHANN GOTTFRIED GALLE, from 1851 to 1895 professor of astronomy and director of the observatory at Breslau, has celebrated his ninety-sixth birthday.

SIR JAMES DEWAR, F.R.S., has been elected an associate of the Belgian Academy.

DR. J. W. L. GLAISHER, F.R.S., has been awarded the De Morgan medal of the London Mathematical Society.

THE Bunsen medal of the German Bunsen Society for Applied Chemistry has been awarded to Professor F. Kohlrausch, of Marburg.

The Munich Academy of Sciences has awarded the gold Liebig medal for services to agriculture to Professor Joseph König, of Munster, Professor Carl Kraus, of Munich, and Professor Max Rubner, of Berlin.

Professor Henry Fairfield Osborn, president of the American Museum of Natural History, has returned to New York after spending several weeks visiting the various natural history museums of Europe.

At the invitation of Dr. W. E. Hoyle, president of the Museums Association of Great Britain, Mrs. Agnes L. Roesler will speak to the members of the society at its meeting to be held at Ipswich, England, during the week commencing July 13, on the educational work of the American Museum of Natural History, in which institution she holds the position of instructor.

The officers of the Anthropological Society of Washington, elected at the annual meeting of the society, Tuesday, May 26, for the current year are as follows: *President,* Dr. Walter Hough; *Vice-president,* Mr. James Mooney; *Secretary,* Dr. John R. Swanton; *Treasurer,* Mr. George C. Maynard; *Additional Members of the Board of Managers,* Dr. I. M. Casanowicz, Mr. J. N. B. Hewitt, Mr. F. W. Hodge, Mr. C. H. Robinson, Mr. W. E. Safford.

At the luncheon on the occasion of the installation of Lord Rayleigh as chancellor of the University of Cambridge, an announcement was made by Sir Andrew Noble that it had occurred to several of Lord Rayleigh's friends, who are not resident members of the university, that some mode of expression should be afforded to the gratification of the scientific world on his election to the high office of chancellor of the University of Cambridge, which would at the same time serve as a mark of recognition of the great obligations to his example and influence under which British science had rested for many years. They had, therefore, arranged to offer to the university a fund large enough to provide an annual award, in such manner as he may select, to be associated with the name of the chancellor in those branches of knowledge in which Lord Rayleigh is preeminent.

As has already been noted here, the Linnean Society of London will celebrate the fiftieth anniversary of the reading of the joint essay by Charles Robert Darwin and Alfred Russel Wallace, entitled: "On the Tendency of Species to form Varieties; and on the Perpetuation of Varieties and Species by Natural Means of Selection," which was presented to the society on July 1, 1858, and preceded by sixteen months the issue of the classical "Origin of Species." The program of the celebration is as follows: (1) An afternoon meeting at which appropriate addresses will be given by eminent biologists, and copies of a special medal, to be called the Darwin-Wallace medal, will be presented. It is proposed that from time to time a copy of this medal in gold or silver may be awarded, and that fellows may purchase copies of the same in bronze. (2) An evening reception in the rooms of the society. (3) A volume to be published containing the full account of the memorable meeting of July 1, 1858, and an account of the jubilee proceedings, including the addresses delivered at the afternoon meeting.

Mr. Henry Lomb, one of the founders of the Bausch and Lomb Optical Company, which has accomplished an important service for science in this country by the scientific instruments which it has made, died on June 13, at the age of eighty years.

Dr. Rudolf Credner, professor of geography at Greifswald, died on June 6, at the age of fifty-seven years.

Dr. A. J. Bélohoubek, professor of general chemistry in the Bohemian University of Prague, has died at the age of sixty-two years.

The chemical interests of central New York State are fostered by the Syracuse Section of the American Chemical Society, formerly the Syracuse Chemical Society. This is an unusually prosperous organization of over a hundred members. It has just closed a very successful year under the presidency of Dr. J. A. Mathews. Eight meetings have been held, at which the speakers have been: E. G. Acheson on "Deflocculated Graphite," E. C. Spurge on "Essential Oils,"

Professor A. H. Gill on "Explosions in Common Substances," Dr. Wm. McMurtrie on "The Tartar Industry," Professor L. P. Kinnicutt on "Sewage Disposal," and Professor G. C. Watson on "Certified Milk," besides local members. The June meeting took the form of an excursion to the State Agricultural Experiment Station at Geneva, N. Y. The following new officers were elected: President, W. M. Booth; vice-president, Dr. F. E. Engelhardt; secretary, Dr. H. C. Cooper; treasurer, L. M. Fenner.

THE annual *conversazione* of the Royal Geographical Society took place on June 17 at the Natural History Museum. The guests were received by the president, Major Leonard Darwin, and Mrs. Darwin and the members of council.

A PARTY of thirty members of the National Hungarian Agricultural Society, accompanied by Count Laszloesterhazy, chairman of the society and president of the Agricultural Society of the county of Feher, on June 18 paid a visit to the agricultural experimental station at Rothamsted. Mr. A. D. Hall, director of the experiments, with whom were Dr. Russell and Dr. Miller, received the visitors, who were afterwards entertained to lunch and proceeded under the direction of Professor Dymond, of the Royal Agricultural Society, on a tour of inspection of the laboratory and the sections.

THE ninety-first annual meeting of the Société Helvétique des Sciences naturelles will be held from August 30 next to September 2 at Glaris. A provisional program, as abstracted in *Nature*, states that at general meetings on August 31 and September 2 the following addresses will be delivered: Professor K. Schröter, of Zurich, on an excursion to the Canary Islands; Professor H. Schardt, of Montreux, on the great erratic boulders of Monthey and neighborhood; Professor A. Riggenbach-Burckhardt, of Bâle, on gravity measurements of the Swiss Geodetic Commission; Professor Ch. E. Guye, of Geneva, on the electric arc as a powerful aid to science and industry; Dr. H. Greinacher, of Zurich, on radio-active substances; and Professor R. Chodat, of Geneva, on Paleozoic ferns, their significance in modern plant paleontology. September 1 will be devoted to sectional meetings and to the annual meetings of the Swiss Geological, Botanical, Zoological and Chemical Societies.

IN view of the spread of the sleeping sickness among men and animals in Equatorial Africa the French minister of the colonies has caused a document drawn up by Dr. A. Kermorgant, inspector-general of the colonial sanitary service, setting forth prophylactic measures to be employed for its prevention to be distributed in the form of brochures printed in French as well as in the different dialects spoken in the colonies.

AN International Association for Cancer Research has been founded at Berlin, to promote the investigation of cancer and the care of cancer patients, the collection and publishing of international cancer statistics, and the establishment of an international center of information on all matters concerning cancer research. Other objects of the association are the publication of an international technical organ and the organization of international cancer conferences. So far, thirteen states, including all the great powers except Great Britain, have joined the association, the seat of which will be at Berlin.

THE Bronx Society of Arts and Sciences is installing a museum in the Lorillard Mansion in Bronx Park, New York City, and announces that it will appreciate the aid of all interested. A museum committee, consisting of Albert E. Davis, chairman; Dr. N. L. Britton, John H. Denbigh, Arthur A. Stoughton, A. T. Schauffler, the Rev. Henry M. Brown, Walter E. Hallett and George E. Stonebridge has been appointed, and a tentative plan has been prepared for suitable collections, classified as follows: (1) Collections illustrating the natural history of the Bronx; (2) collections illustrative of the civil history of the Bronx; (3) collections illustrative of the industries of the Bronx; (4) educational features of the Bronx; (5) the park system of the Bronx; (6) library.

UNIVERSITY AND EDUCATIONAL NEWS

An arrangement has recently been effected by means of which the University of Buffalo has acquired from Erie County, N. Y., one hundred and four acres of land to be used for university purposes. The tract is at the summit of the limestone ridge at the northern edge of the city, adjacent to the country club. The Medical Department of the University of Buffalo was founded in 1846 and three other professional schools have been organized since that time. The need for an academic department has long been felt and its organization now seems in a fair way to be accomplished. The land above mentioned will be devoted to that purpose.

Dr. William Edward Wilson, F.R.S., of Daramonahouse, county Westmeath, who died on March 6, leaving personalty valued at £50,121, bequeathed his philosophical and scientific instruments to Trinity College, Dublin, for use in the physical laboratory, and his telescope and its machinery to the Radcliffe Observatory at Oxford.

Mr. Charles Edwin Layton, of London, has made a large number of public bequests, including $30,000 to King's College, London, for scholarships to be awarded to those who show the best promise of genius and aptitude in original scientific work.

The trustees of the Massachusetts Agricultural College have recently established a new department of hygiene and physical culture. Percy L. Reynolds, M.D., has been placed in charge of the department. Dr. R. D. MacLaurin, research chemist at the experiment station, has been elected lecturer of organic chemistry in the college.

Dr. H. J. Davenport, assistant professor of economics in the University of Chicago, has been appointed professor of economics in the University of Missouri.

Dr. Harvey Carr, professor of psychology in the Pratt Institute, will succeed Dr. J. B. Watson (professor-elect in Johns Hopkins University) as assistant professor of psychology in the University of Chicago. Dr. Carr will have charge of the work in comparative psychology and will share in the conduct of the general experimental courses.

Dr. Clarence S. Yoakum, of the University of Chicago, has been appointed instructor in psychology at the University of Texas.

Dr. Victor E. Emmel, Austin teaching fellow in embryology and histology, Harvard Medical School, has accepted the appointment of instructor in histology and embryology in the Medical Department of Washington University, St. Louis, Mo.

At the Indiana University the following promotions have been made: From junior professor to professor, Wm. A. Rawles, Ph.D. (Columbia), economics and political science; S. C. Davisson, Sc.D. (Tübingen), and D. A. Rothrock, Ph.D. (Leipzig), mathematics; W. G. Moenkhaus, Ph.D. (Chicago), physiology; L. S. Davis, Ph.D. (Marburg), chemistry; A. G. Pohlman, M.D. (Buffalo Med. Col.), anatomy; W. R. Alburger, M.D. (Pennsylvania), pathology. W. A. Cogshall was promoted from assistant professor to associate professor of astronomy, and Dr. Charles Heseman from instructor to assistant professor of mathematics.

Dr. Wahrmund, professor of canon law at Innsbruck University, whose pamphlets criticizing Catholic dogmas led to a demand from the Papal Nuncio for his removal, and whose recent attempt to resume his lectures caused the closing of the university, has been transferred in a similar capacity to the German University at Prague.

Professor P. Schiefferdecker has been named the director of a new subdivision of the Anatomical Institute in Bonn.

At Cambridge Dr. Anderson has been appointed university lecturer in physiology; Mr. F. H. A. Marshall, M.A., Christ's, university lecturer in agricultural physiology; Mr. C. G. Lamb, M.A., Clare, university lecturer in electrical engineering, and Mr. C. E. Inglis, M.A., King's, university lecturer in mechanical engineering, all for five years.

Mr. H. J. Mackinder, M.A., who has resigned the office of director of the London

School of Economics and Political Science, to which he was appointed in 1903, retains the readership in geography, to which, under its then title, he was appointed in 1902.

DISCUSSION AND CORRESPONDENCE

MENDELIAN PROPORTIONS IN A MIXED POPULATION

To THE EDITOR OF SCIENCE: I am reluctant to intrude in a discussion concerning matters of which I have no expert knowledge, and I should have expected the very simple point which I wish to make to have been familiar to biologists. However, some remarks of Mr. Udny Yule, to which Mr. R. C. Punnett has called my attention, suggest that it may still be worth making.

In the *Proceedings of the Royal Society of Medicine* (Vol. I., p. 165) Mr. Yule is reported to have suggested, as a criticism of the Mendelian position, that if brachydactyly is dominant "in the course of time one would expect, in the absence of counteracting factors, to get three brachydactylous persons to one normal."

It is not difficult to prove, however, that such an expectation would be quite groundless. Suppose that Aa is a pair of Mendelian characters, A being dominant, and that in any given generation the numbers of pure dominants (AA), heterozygotes (Aa), and pure recessives (aa) are as $p:2q:r$. Finally, suppose that the numbers are fairly large, so that the mating may be regarded as random, that the sexes are evenly distributed among the three varieties, and that all are equally fertile. A little mathematics of the multiplication-table type is enough to show that in the next generation the numbers will be as

$$(p+q)^2 : 2(p+q)(q+r) : (q+r)^2,$$

or as $p_1 : 2q_1 : r_1$, say.

The interesting question is—in what circumstances will this distribution be the same as that in the generation before? It is easy to see that the condition for this is $q^2 = pr$. And since $q_1^2 = p_1 r_1$, whatever the values of p, q and r may be, the distribution will in any case continue unchanged after the second generation.

Suppose, to take a definite instance, that A is brachydactyly, and that we start from a population of pure brachydactylous and pure normal persons, say in the ratio of 1:10,000. Then $p=1$, $q=0$, $r=10{,}000$ and $p_1=1$, $q_1=10{,}000$, $r_1=100{,}000{,}000$. If brachydactyly is dominant, the proportion of brachydactylous persons in the second generation is 20,001:100,020,001, or practically 2:10,000, twice that in the first generation; and this proportion will afterwards have no tendency whatever to increase. If, on the other hand, brachydactyly were recessive, the proportion in the second generation would be 1:100,020,001, or practically 1:100,000,000, and this proportion would afterwards have no tendency to decrease.

In a word, there is not the slightest foundation for the idea that a dominant character should show a tendency to spread over a whole population, or that a recessive should tend to die out.

I ought perhaps to add a few words on the effect of the small deviations from the theoretical proportions which will, of course, occur in every generation. Such a distribution as $p_1 : 2q_1 : r_1$, which satisfies the condition $q_1^2 = p_1 r_1$, we may call a *stable* distribution. In actual fact we shall obtain in the second generation not $p_1 : 2q_1 : r_1$ but a slightly different distribution $p_1' : 2q_1' : r_1'$, which is not "stable." This should, according to theory, give us in the third generation a "stable" distribution $p_2 : 2q_2 : r_2$, also differing slightly from $p_1 : 2q_1 : r_1$; and so on. The sense in which the distribution $p_1 : 2q_1 : r_1$ is "stable" is this, that if we allow for the effect of casual deviations in any subsequent generation, we should, according to theory, obtain at the next generation a new "stable" distribution differing but slightly from the original distribution.

I have, of course, considered only the very simplest hypotheses possible. Hypotheses other that that of purely random mating will give different results, and, of course, if, as appears to be the case sometimes, the character is not independent of that of sex, or

has an influence on fertility, the whole question may be greatly complicated. But such complications seem to be irrelevant to the simple issue raised by Mr. Yule's remarks.

G. H. Hardy

Trinity College, Cambridge,
April 5, 1908

P. S. I understand from Mr. Punnett that he has submitted the substance of what I have said above to Mr. Yule, and that the latter would accept it as a satisfactory answer to the difficulty that he raised. The "stability" of the particular ratio 1:2:1 is recognized by Professor Karl Pearson (*Phil. Trans. Roy. Soc.* (A), vol. 203, p. 60).

PURE CULTURES FOR LEGUME INOCULATION

In the 1907 Report of the Biologist of the North Carolina Agricultural Experiment Station, Dr. F. L. Stevens and Mr. J. C. Temple report some work upon cultures of the nodule-forming organisms of legumes. The cultures used were obtained from the United States Department of Agriculture. The investigators have presented their data in such a manner that the value of pure cultures for inoculating legumes appears questionable and their conclusions emphasize their attitude of disapproval. In carefully reviewing their report, a very brief outline of which appeared in Science, Vol. 26, 1907, p. 311, I have been impressed with the fact that the inferences drawn by the casual reader would almost certainly be unwarrantably antagonistic to the use of pure cultures for inoculating legumes. The investigators' objections to the actions of cultures supplied by this department are briefly as follows:

A considerable number of the cultures hermetically sealed in glass were sterile at the time they were examined by Dr. Stevens and Mr. Temple. The misconception in regard to the viability of cultures distributed by the department at the present time could have been prevented by the insertion of a footnote explaining that since July, 1906, small bottles with wax seals have been substituted for small tubes hermetically sealed in the flame of a blast lamp. It is surprising to me that four out of seven of the old-style cultures examined by Dr. Stevens should have been sterile, as my own investigations previous to adopting this method for distribution indicated that about one half of one per cent. of the cultures sealed in this way in routine work would be injured or sterilized by the heat of sealing. The law of chance must perhaps be invoked to explain the discrepancy in our figures. It must be remembered, however, that the cultures spoken of at this time are the old-style liquid cultures, and that the cultures distributed since July, 1906, are not open to criticism of this sort.

It is surprising to me also to learn that during the multiplication period conducted in the practical manner outlined for use on the farm such great contamination should have become manifest. Two years ago I had small samples of these gross cultures prepared on the farm returned to me by farmers in various parts of the country for examination, the sample being taken and mailed to me at the time the culture was applied to the seed. This, of course, allowed for greater development of contaminations than would have taken place at the time the culture was applied to the seed. Even with this handicap about two per cent. of the cultures received from the farmers were apparently pure, and if contaminated the contamination was evidently very slight indeed. About sixty per cent. were contaminated, but not excessively so, it being easy in all of these cases to isolate large numbers of *Pseudomonas radicicola*. The remainder were in rather bad condition, although I doubt if ten per cent. of the entire number received were so seriously contaminated as to be worthless.

The description of the pot experiments conducted by Dr. Stevens and Mr. Temple is confusing. In the first place, the sterilizing of soil by heating is well known to injure the soil seriously, and, regardless of the condition of the nodule-forming bacteria introduced, it is an open question whether soil sterilized by heating would allow nodule formation until a normal bacteriologic flora and normal soil conditions generally had been reestablished. It is impossible to determine whether any

attempt has been made to find out if injurious effect is produced by sterilizing this soil, unless we are to understand that pots Nos. 4 and 5 in tables Nos. 1, 2, 3, 4, 5, 6, 7, 8, 11 and 12 are inoculated with a mixture of culture and unsterilized soil. If this premise is correct it is evident that neither culture nor soil inoculation was able to produce nodules in the sterilized soil. If, on the other hand, one is to understand that pots Nos. 4 and 5 in tables Nos. 1, 2, 5, 7 and 11 are inoculated with culture mixed with sterilized soil then we must admit that no true parallel exists between the two series of experiments, and that it is impossible to determine what the effect of the use of pure cultures has been. There is also a contradiction between the headings and subheadings of some of the tables, making it impossible to determine whether that particular series was inoculated or uninoculated.

For the above reasons I would take exception to the summary of results reported by Dr. Stevens and Mr. Temple, and return the Scotch verdict of not proven to their strictures upon pure cultures and the pure culture method of inoculation. The note following the summary referring to Farmers' Bulletin No. 315, "Progress in Legume Inoculation," issued January 11, 1908, quotes the figures reported in that publication in a way that is very misleading. It is obviously impossible to determine whether or not a culture produced nodules if the entire crop is withered by drought or carried away by floods or if other uncontrollable factors entirely apart from the question of inoculation have destroyed the crop. It is, therefore, unfair to compare the 2,037 doubtful results with the 1,770 successes. As stated in Farmers' Bulletin 315, "the successes credited to the culture have been so recorded only when a clear gain was shown to be due to inoculation. A less strict interpretation of the doubtful reports would place many of them in the column of successes, and undoubtedly many classed as failures to secure inoculation would prove upon adequate investigation to have been failures from causes other than deficient nodule formation." If one must express the result in percentages it would be necessary to consider only the failures and successes, making the percentage of successes 78, instead of less than 50.

In closing, I wish to emphasize the necessity in experimental work of paying more attention to the soil conditions which may affect nodule formation. Some reasons for this Mr. Robinson and I have clearly indicated in Bureau of Plant Industry Bulletin No. 100, Part VIII., "Conditions Affecting Legume Inoculation."

KARL F. KELLERMAN
WASHINGTON, D. C.

A STUDY OF THE REMARKABLE ILLUMINATION OF THE SKY ON MARCH 27, 1908

ON the night of Friday, the twenty-seventh of March, 1908, between the hours of 7:45 and 8:30, there was an unusual illumination of the heavens. The display was noted by many observers at Sandy Hook, N. J., and at Montclair, N. J. Some of the New York papers stated that the phenomenon was also visible at Hartford, Conn. Beyond a casual and unscientific reference to the matter in the daily press at the time, I have not been able to find any further reports or study of the phenomenon.

The 27th of March was a remarkably clear and warm day, the temperature mounting well above 70 degrees. The evening was also clear, but decidedly cooler. There was no moon, but Venus shone unusually bright in the western sky. This last fact is mentioned particularly, because the best authorities state that the light of a brilliant evening star is sufficient to preclude any marked illumination like that observed. Every one whom I have interviewed informs me that he had never before witnessed any such display. With the exception of one eye-witness at Millburn, N. J., all of my information has been obtained from observers at Sandy Hook, N. J. I was so unfortunate as to witness the last part of the spectacle, only. Details beyond my own knowledge are furnished from accounts given me by army officers stationed at Sandy Hook and members of their respective households.

The illumination was first noted at about 7:45 P.M. It consisted of a bright nebulous band rising north of west from about twenty degrees above the horizon. The light extended across the sky to near the north of east horizon, diminishing in brightness from west to east, the bands in the east and west being connected by three separate bands. At about 8:15, the illumination faded, except the western solid band, which persisted for about ten minutes. Before it disappeared, however, a series of short narrow shafts, nearly parallel to one another, appeared about fifty degrees above the horizon in a direction slightly west of north. The eastern-western illumination was steady, while the northern shafts were "trembly," somewhat suggesting the aurora borealis. It should be remembered, however, that there were no lights of whatever nature in the north, except these detached shafts.

It would seem plausible on first thought to attribute this display to the zodiacal light, or the aurora borealis, or to a combination of the two. The season of the year and the location of the steady glow appear to indicate the zodiacal light. This is rarely seen in our latitude, except near the equinoctial periods; when the inclination of the ecliptic to the horizon is at a maximum—and then only in localities where outdoor illumination is not general, and the air is unusually clear. In the spring the light is first seen as a pale illumination in the west, suggesting an unusual prolongation of twilight. In the autumn, the phenomenon, often called the "false dawn," is visible before daybreak. The zodiacal light is of frequent occurrence in low latitudes, where the illumination sometimes extends across the meridian, forming a secondary display in the east. At times a detached luminous patch is observed in the sky, about 180 degrees from the sun's position. This is called the "gegenschein," or "counter-glow." I can recall no authentic reports of the appearance in our latitude of a secondary light or the counter-glow.

Returning to the exhibition of last March, the zodiacal light hypothesis fails to account for the detached shafts high above the horizon to the west of north. Some writers appear to make a distinction between auroral displays ("fictitious" auroras, as it were), and the characteristic aurora borealis. Reports of the simultaneous displays of the zodiacal light and auroral phenomena are matters of authentic record. In the case under discussion, there is a chance that two independent phenomena were occurring at the same time, but the chance was infinitesimally small. Moreover, one of the most pronounced sensations of the beholder was that he was witnessing *one* phenomenon, with *one* cause.

As is generally known, neither the aurora borealis nor the zodiacal light has been quite satisfactorily explained. The latter has been variously attributed to extensions of the sun's corona, to the reflection of the sun's light from masses of meteoric matter revolving around the sun in planes near the ecliptic, or around the earth itself. Chaplain G. Jones, of the U. S. Navy, who, in 1855, made a particular study of the zodiacal light while on duty in Asiatic waters, could not explain the disposition of the light as he observed it on any hypothesis other than the last mentioned. Reports have also been published of the appearance of a similar band about the moon.

The main difficulty in the way of the study of the zodiacal light is found in the fact that, owing to the nature of the light, the telescope can not be brought into service. Again, a brilliant display is a rarity, except in equatorial latitudes, where observatories are very scarce. If the light were due to the sun's corona, its spectrum should be identical with that of the solar corona, and if due to reflected sunlight alone, the polariscope should show that the light is polarized. Observations with both kinds of instruments show conflicting—or rather mixed results.

The following hypothesis is submitted as a possible explanation of the phenomenon of last March, and is believed to be in line with the latest theory as to the constitution of matter.

Whatever the sun's corona may be, it is not a heat phenomenon pure and simple. If it is

composed of matter at all, it must be in that sub-atomic condition characteristic of the manifestation of electricity. The corona from its very appearance suggests a streaming out from the sun of attenuated matter, or of force. That a repellant force actually emanates from the sun is shown by the solar action upon the tails of comets, always turning them from itself. It seems to have been fairly well established that all substances are radio-active, differing only in degree in the possession of this property. It is but a step further to conclude that all celestial bodies are sending out emanations of matter in the most attenuated state, and that these effects, in the case of the sun, become visible as the solar corona. Following this trend of thought, we may safely assume that the earth and moon each has its own corona. The aurora borealis then may be an exhibition of our corona shining by its own light, the angle at which the sun strikes the corona being such as to preclude the reflection of sunlight to the observer's eye. The zodiacal light might be explained as being due *mainly* to sunlight reflected from our own coronal matter. As in this case we should not be viewing the earth corona by its own light, the flickering effect of the northern light would not be prominent.

The hypothesis here offered seems to account for the puzzling mixed spectra of the so-called zodiacal light. It further explains the existence of the shafts high in the north and the undecided character of the light, on the evening of March 27. Both the zodiacal and auroral theory utterly fail to account for these. Wandering into the domain of conjecture, it is interesting to speculate whether the solar, terrestrial and lunar coronas are identical in nature. If they are not, it would seem to indicate that radio-activity was a function of the heat of the radiating body, and we might expect the spectra to group themselves in the order named as regards simplicity. If the spectra should prove to be the same, we might fairly conclude that coronal material is the final form of disintegrating matter, as a nebula is the first form.

WILMOT E. ELLIS

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QUOTATIONS

THE CAVENDISH LABORATORY

LORD RAYLEIGH, as chancellor of the University of Cambridge, performed his first official act by opening the new wing of the Cavendish Laboratory, which Lord Rayleigh, as a Nobel prize-man, presented to the university. The ceremony was all the more interesting because, as Professor J. J. Thomson observed, it occurred upon the anniversary of the opening of the original Cavendish Laboratory, which the university owed to the generosity of the seventh Duke of Devonshire, who was chancellor in 1874. During the thirty-four years that have elapsed since the founding of the laboratory, Lord Rayleigh has been closely connected with it, and the physical research which it was designed to promote. His interest in it, indeed, began, as he remarked yesterday, before it existed. He had then become acutely aware of the scientific destitution of the university, and of the difficulty of acquiring systematic scientific training. Much good work had been done in physical research, but it had to be carried out by earnest students either in their own houses or in some college where the equipment was more meager than students of the present day can easily realize. Lord Rayleigh's activity in seeking a remedy for that state of things was much greater than might be inferred from his characteristically modest remark that he had some share in urging Clerk-Maxwell to accept the appointment of professor of experimental physics. That brilliant man's tenure of the post was not a long one, and on his lamented death in 1879 Lord Rayleigh succeeded him as Cavendish professor. During the five years of his professorship Lord Rayleigh carried out some fundamental researches with results which more recent investigations have only corroborated. Since that time the post has been held and adorned by Professor J. J. Thomson; but Lord Rayleigh's interest in the laboratory and its work has been continuous and keen. The extension which he has given to its accommodation was very urgently needed on account of the steady growth in the

number of students pursuing original research; but the university is poor and, but for his timely aid, might have waited long for this addition to its teaching facilities. The present phase of scientific investigation is marked by a need for costly apparatus which earlier experimenters do not seem to have felt so acutely and which certainly could not have been supplied. Lord Rayleigh, we may judge from a reference to his earlier studies, does not approve the tendency to disparage simpler methods of research, and it is conceivable that some day a great man will again arrive at an epoch-making discovery by means surprisingly simple. Originality is perhaps not always fostered by a wealth of apparatus, still there is an immense amount of work at the present day which can be carried on nowhere but in well-equipped laboratories like the Cavendish. When the present extension has again been overtaken by the influx of students, Cambridge will no doubt again find among her sons some one to emulate the liberal and public-spirited action of her present distinguished chancellor.—The London *Times*.

SCIENTIFIC BOOKS

Social Psychology: An Outline and Source Book. By Edward Alsworth Ross. New York, The Macmillan Company. 1908. Pp. xviii + 372.

It must have required considerable courage on the part of Dr. Ross to venture a new book on social psychology. For although he says in the preface that "the ground is new," still, as he well knows, and as his materials show, the subject itself is very old and has been worn threadbare. The only thing that could be done, and the thing that he has virtually done, was to undertake a new compilation of the matter already extant. For, without making a count, it seems safe to say that fully one half of the matter of the book is between quotation marks, and its character as a compilation would have been apparent if all the citations had been printed in different type. But this is very far from being a criticism of the book. Indeed, under the circumstances it is its highest commendation.

And yet he has by no means utilized all the literature. Professor Sumner's "Folkways" reached him too late for use, but it would have been an inexhaustible source of facts for such a work. One of the most important omitted works is Michailovsky's elaborate treatise on "The Heroes and the Crowd," which first appeared in *Russian Wealth* in 1882 and was republished in a collection of essays in 1896.[1] In this essay imitation and suggestion are ably handled, and many of Tarde's best thoughts are anticipated. The religious epidemics of the middle ages are described in detail, and contagious manias of suicide and homicide are fully treated. The subject of the influence of the mind on the body, now brought into such prominence by christian science, received special attention, not merely in recording the alleged instances of "stigmata," but in enumerating many other illustrations. In no other work, so far as I know, is the case of Jacob's "ring-streaked, speckled and spotted" sheep and goats referred to this principle, not only as illustrating its effect on animals, but as showing that it was understood by Jacob and effectively acted upon.

Another of the older, much neglected works is Carpenter's "Mental Physiology," 1875, which deals in a scientific way with many of the psychic phenomena now referred to social psychology. Carpenter laid great stress on the principle which he called "expectancy," which is really none other than that now perhaps less happily called "suggestion."

But of course Tarde's works stand out as the leading contributions to social psychology, and it is refreshing to see them prominently recognized by Dr. Ross in the preface to this book. It has become so much the custom of American writers, while reiterating the truths they contain, to ignore their source, that this manly acknowledgment will be appreciated by all admirers of the great French sociologist.

Dr. Ross well says that social psychology is not the same as psycho-sociology. It is not

[1] "Heroi i Tolpa," Russkoe Bogatstvo, 1882; Sochineniya, Vol. II., St. Petersburg, 1896, pp. 95–190.

the psychology upon which sociology rests, and which furnishes society with both its motor power and its guidance. That is an entirely different and far more important science. Social psychology is the science of the mutual influence of psychic phenomena. Mr. H. G. Wells has properly described it as "an exhaustive study of the reaction of people upon each other and of all possible relationships."[2]

Social psychology, thus understood, has been treated by all kinds of writers. Very little of value has been contributed by the psychologists proper. When they approach it they load it with such a mass of technical terms, borrowed from their psychological "jargon"—dialectic, ego, alter, socius, eject, project, subject, etc., with the innumerable derivatives of these terms, that, however commonplace such ideas may be, the reader's mental stomach is so turned by their pedantic iteration that it is incapable of following what little thought they may represent.

But many writers besides Tarde have treated special aspects of the subject with clearness and force. Among these Dr. Ross himself must be counted and placed in the front rank, for his "Social Control" and other writings deal primarily with social psychology. In the present work he lays under contribution a great array of authors and a vast literature. No attempt can be made here to summarize this body of knowledge. The arrangement of the material is the original part of the work, and this could not probably be improved upon.

In some of the later chapters Dr. Ross has been able to free himself more fully from his historical bearings, and to strike out into fields more distinctly his own. This is especially the case with Chapter XV., on the Relation of Custom Imitation to Conventionality Imitation, and Chapter XVI., on Rational Imitation, which is the coming form of imitation based on intelligence and scientific knowledge. Chapter XVIII., on the rôle of Discussion, is also luminous, and pushes the subject some distance beyond the point where Bagehot left it. Chapter XXI., on Com-

[2] "A Modern Utopia," New York, 1907, p. 83.

promise, is all too brief, and John Morley is not mentioned.

The final chapter (XXIII.), on Disequilibration, deals with invention (in the Tardean sense), and displays an astonishing grasp of the progress of human thought. No one has better shown how it is that premature discoveries lie dormant till the world is ready for them. Under the heading that "the higher the degree of possibility, the sooner the invention is likely to be made," he says (pp. 359–360):

> The inventions (or discoveries) in a particular field—and often those in different fields—are in a chain of dependence which obliges them to occur in a series. Each ushers in a train of possibles. Now when no intervening invention needs to be made, an invention may be said to be in the *first* degree of possibility. When it is contingent on another yet to be made, it is in the *second* degree of possibility. And so on. Now, when an invention or discovery reaches the first degree of possibility, it is *ripe*. Thus, after Kepler announces the laws of planetary movement, the discovery of the principle of universal gravitation is in order at any moment. After Galileo has proclaimed the laws of the pendulum, its use in time-keeping needs but a single stride. The electric telegraph is due any time after Ampère's discoveries. The invention of Crookes's tubes brings the X-ray into the foreground of possibility. After the discovery of the Hertzian waves, a few short steps bring wireless telegraphy upon the scene.

And in showing "how society can promote invention," he significantly adds (p. 360):

> The difficulty of making the combination of ideas for any particular invention will depend upon the number of persons who possess these ideas, and on the frequency in this number of individuals with the intellectual capacity necessary to combine the ideas into the invention. There is no way of affecting the latter condition, for the genius is in no wise a social product; but organized society can affect the former condition. A universal system of gratuitous instruction with special aid and opportunities for those who show unusual power amounts to an *actualizing* of all the potential genius in a population, and is the only rational policy for insuring a continuous and copious flow of inventions. It is hardly necessary to point out that only a stimulating, equipping education can mature geniuses. A régime that prunes, clips and trains minds levels genius

with mediocrity. A schooling devised primarily to produce good character, or patriotism, or dynastic loyalty, or class sentiment, or religious orthodoxy may lessen friction in society, but it can not bring genius to bloom. For this the prime essentials are *the communicating of known truths* and *the imparting of method.*

On the whole we have in this work an able marshaling of the knowledge thus far brought to light on the subject of social psychology, and a clear, untechnical, while at the same time often eloquent, discussion of the laws, principles and leading truths of that rather subtle and recondite branch of sociology.

Lester F. Ward

The Solar System: A Study of Recent Observations. By Charles Lane Poor, Professor of Astronomy in Columbia University. New York, G. P. Putnam's Sons.

From the above sub-title we naturally look for something different from the ordinary text-book on astronomy. Nor shall we be disappointed in this respect. The author informs us that the work grew out of a series of lectures, that these were mainly historical and were used to supplement standard text-books and to guide the students in their reading. Though the work includes much which may be found in the ordinary text-book, there is also much not usually to be obtained from such sources. On the other hand, some matters of great interest are hardly touched on in the present work. We mention by way of illustration the minor planets and the subject of eclipses.

The lecture notes seemed to have been followed quite closely. We are informed, for instance, page 235, that the last opposition of Jupiter took place in the latter part of December, 1906, and that the next will fall on the last of January and the first of February, 1908. We also learn that the last favorable eclipse of the sun occurred August 30, 1905, and the next eclipse which can be utilized, will take place October 10, 1912, and will be observable in South America. Precisely what disposition has been made of the eclipse of January 3, 1908, does not appear.

The subject of the solar energy is treated quite fully, with the different theories as to its maintenance, its constancy and results of measurement of the same. We confess, however, to finding ourselves a little disconcerted on learning, page 126, that such measurements are of no vital importance.

Naturally the reader in search of the latest and most interesting information relating to the solar system will turn to the planet Mars. The author acknowledges to having given to this planet more space than the subject really warrants. We find an entire chapter of twenty-four pages entitled "Has Mars Canals?" The leading authorities—Schiaparelli, Lowell, Newcomb, Barnard and many more are quoted at considerable length, with the result that we are finally told that "very little is actually known in regard to the conditions existing on Mars," that many of the problems are psychological and not physical. The seeker after truth, therefore, finds himself at the end of the chapter precisely where he stood at the beginning.

The author gives us an account of the discovery of the seven satellites of Jupiter, beginning with Galileo and ending with Perrine, but the ink is hardly dry on the page before the discovery of an eighth at Greenwich calls for a revision of the chapter, thus illustrating the impossibility of keeping such a work strictly up to date. In this connection let it be noted that the name of satellite IV. is Callisto, not Calypso.

Each planet from Mercury to Neptune is taken up in turn. Many facts of historical interest are given, among which are some old friends not usually found in the text-books, such as the famous Moon Hoax of 1835.

Chapters on comets, on meteors and on the evolution of the system close a very interesting and suggestive volume.

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SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Experimental Zoology, Vol. V., No. 3 (March, 1908), contains the following papers: "The Physiology of the Nervous System of the Razor-shell Clam (*Ensis directus* Con.)," by Gilman A. Drew. The

experiments indicate that, while the ganglia all have their special functions to perform, the pedal ganglia are under the direct control of the cerebral ganglia and are not capable of originating motor impulses when separated from them. Association fibers between the ganglia are well developed and impulses may finally reach muscular organs by roundabout paths when the usual paths have been destroyed. "The Influence of Grafting on the Polarity of Tubularia," by Florence Peebles. "A Study of the Germ Cells of Certain Diptera, with reference to the Heterochromosomes and the Phenomena of Synapsis," by N. M. Stevens. This article is a study of the germ cells of nine species of Muscidæ and Syrphidæ. The spermatogonia contain an unequal pair of heterochromosomes, and the oogonia a corresponding equal pair. The dimorphism of the spermatozoa and its relation to sex determination are the same as in many of the Coleoptera and Hemiptera. In synapsis there is a side-to-side pairing of homologous maternal and paternal chromosomes, and a similar pairing occurs in the prophase of each spermatogonial and oogonial mitosis, and also in ovarian follicle cells. "Momentary Elevation of Temperature as a Means of Producing Artificial Parthenogenesis in Starfish Eggs and the Conditions of its Action," by Ralph S. Lillie. Momentary warming of unfertilized starfish eggs, *e. g.*, to 35° for 70 seconds, during early maturation, results in membrane formation, cleavage and development to an advanced larval stage. Exposure to *n*/2000 KCN solution during, before and after such warming is highly favorable to parthenogenetic development. Initiation of development can not, therefore, depend on acceleration of oxidative processes. Apparently, processes of some other nature—hydrolytic or reducing—are most immediately concerned in fertilization in these eggs. "The Sex Ratio and Cocooning Habit of an Araneid and the Genesis of Sex Ratio," by Thomas H. Montgomery.

THE *Istituto geografico militare* of Italy, situated at Florence, has published a new edition of a most effective map of Vesuvius in colors, on a scale of 1:25,000 (2 francs), indicating all determinable lava flows, with their dates down to 1906; also a map of Vesuvius in black, scale 1:10,000 in six sheets (4.50 francs complete), and two special maps of the cone of the volcano, 1:10,000, before and after the eruption of 1906 (each one franc). Those who are thinking of ordering the general map of Italy, 1:100,000, will do well to specify the edition "Systema Gliamas," now in course of publication in four colors (1.50 francs a sheet: 27 sheets published; edition on thin paper preferable). W. M. D.

AT the sitting of the Paris Academy of Sciences on June 16 M. Poincaré gave, according to the London *Times,* particulars of a discovery by M. Devaux Charbonnel of a method of photographing the sounds of the human voice with sufficient precision to enable the record to be read. Vowels and consonants are combined with a Blondel oscillograph. The latter, which is extremely sensitive, impresses the sounds upon a photographic plate in the form of curves characteristic of each category. With a little practise it is possible to decipher these characters.

THE COCO BUD-ROT IN CUBA

AN appropriation has been approved by the provisional governor of Cuba, Hon. Chas. E. Magoon, for $14,000 to be expended in the next year for combating the coconut bud-rot in the district of Baracoa.

The bud-rot is the most serious disease of the coconut palm. It occurs in Cuba, Jamaica, Trinidad, British Honduras, British Guiana, and perhaps in India, Ceylon and East Africa. Many years ago it spoiled the business of coconut growing in most parts of Cuba. It usually leaves a few scattered trees and this is the condition now around Havana. Even in the Baracoa district, which is especially adapted to coconuts and which escaped the disease longer than most parts of Cuba, it has existed for probably twenty years, but it has increased gradually and has only become alarming within the last few years. The total production of this district is now

estimated at two million nuts monthly (including those fed to animals), whereas it was formerly estimated at three million monthly. The decrease is due to bud-rot.

Much work has been done on this trouble in the British West Indies, where the destruction of sick trees and the use of Bordeaux mixture as a preventive have given good results.

Considerable attention has also been given to the bud-rot by the United States Department of Agriculture, which, at the request of the planters, sent Mr. Wm. Busck to Baracoa to investigate the disease in 1901. The measures which he recommended are substantially the same as those which are now to be carried out. The results of his work are given in Bulletin No. 38, Division of Entomology, U. S. Department of Agriculture. In the spring of 1904, Dr. Erwin F. Smith, of the U. S. Department of Agriculture, spent some time in Cuba studying the disease. Mr. Busck had regarded it as caused by a fungus, *Pestalozzia palmarum,* but Dr. Smith regarded it as a bacterial rot. The results of Dr. Smith's work are given in SCIENCE, N. S., Vol. XXI., No. 535, p. 500, March 31, 1905. During the past year his investigations have been continued at Baracoa and other West Indian coconut-producing points.

The subject has been written on largely by Cuban authorities, notable among whom is Dr. Carlos de la Torre, of the University of Havana; and the Department of Vegetable Pathology of the Estación Central Agronómica de Cuba has given it as much attention as possible among many other problems during nearly four years, but without being able thus far to reproduce the disease at will.

The work for which the appropriation has just been made by the Cuban government is in continuation of investigations undertaken by the Cuban Department of Agriculture through the Estación Central Agronómica in March, 1907. At this time Mr. Wm. T. Horne, chief of the Department of Vegetable Pathology of the Estación Central Agronómica, was sent to Baracoa to study means of eradicating the disease and during the summer he made three other visits. The trouble was found widely distributed and progressing at an alarming rate. The principal work done was the treatment of several small groves with the most thorough sanitation possible—*i. e.,* dead and hopelessly sick trees were felled and burned, while new cases and suspected trees were flamed out. In two of the groves which were treated the disease was passing across, killing every tree in its path. The work showed that all trees with fairly well developed cases die. It was thought that some very early cases were saved by the flaming; at least the disease was checked. It was not stamped out in the groves, but the results were as satisfactory as could have been expected in decreasing the infection.

The work now to be undertaken is probably the most extensive measure ever adopted to control the bud-rot of coconuts and it is most sincerely to be hoped that this aid from the general government will sufficiently suppress the disease so that by a vigorous system of inspections it may be thoroughly and permanently held in check.

SPECIAL ARTICLES

REGARDING THE FUTURE OF THE GUANO INDUSTRY AND THE GUANO-PRODUCING BIRDS OF PERU[1]

To the people of Peru the importance of the guano industry needs no emphasis, but it is well, first, to make clear just what is the alarming condition with which the country is confronted, and what is the object to be striven for.

Every one knows that the great ancient deposits of guano are now almost non-existent. As these deposits have been successively exhausted of various high grades, there is now left only the lowest grades that it is profitable to extract, and also some supplies of such very low grade that under present conditions they are not marketable. However, the birds are

[1] The present paper, very slightly modified from a report recently submitted to the Peruvian government and published officially in Spanish, is presented in English with the kind permission of Sr. Larrabure y Correa, Director de Fomento in Lima.

each year making new deposits, especially on their nesting-grounds, and this new fresh guano usually has a very high per cent. of nitrogen and a comparatively low per cent. of sand. Now, as the remaining deposits of old guano are rapidly being exhausted, the annual gross output of guano is bound to decrease very considerably, and the industry will be dependent entirely upon the yearly deposit of the birds.

Probably the general impression held in other countries regarding the accumulations of guano in Peru has been that they were comparable to coal formations, in that they represented the very gradual accumulations of untold years, and were, practically speaking, a finished formation. By the very nature of such deposits they would surely be exhausted sooner or later. Unfortunately this partly erroneous impression seems to have been the controlling one both in Peru and outside. For, while many of the intelligent men of intimate acquaintance with the islands have recognized the producing value of the modern birds, the whole policy of extractors and the government has been, until rather recently, that of making the most of the old deposits, with general disregard of the productive birds.

When one sees one thousand tons of new guano of the highest grade taken from an area of twelve thousand square meters, where the birds have been nesting for much less than one year, when one observes on a neighboring island an area, five times greater, completely covered with birds at their nests, when one, later, finds this latter flock increased by nearly fifty per cent., as the birds have been driven from other islands—with such convincing appeals to the eye and the mind, one will not fail to recognize the present producing value of the birds.

For this new guano of annual production, there is, on the one hand, the insatiable demand of the export trade, and, on the other, a steadily growing requirement for the needs of national agriculture. Since it is generally estimated that the agriculture of Peru requires about forty thousand tons per year, and since this quantity is surely more than the present yearly production, it follows that the impression regarding the exhaustibility of the guano deposits may, doubtless will, prove true, as far as the North American or European consumer is concerned. More than this, it is inevitable that, with the continuance of the present conditions, national agriculture will soon be forced against an actual and disastrous shortage of this fertilizer. The hope of the future lies, then, in the effort to make the annual deposits of guano greater in future years than it now is. National agriculture may have an additional hope, also, that arrangements may be made with the exporting company whereby a greater proportion, if not all, of the fresh guano of high grade may be available for domestic use.

I. THE AIM IN VIEW

To realize the hope that the annual deposit will be greater in future years, it is necessary to cease treating the birds as wild animals whose homes men may invade almost like beasts of prey to seize the useful product, regardless of the producing birds. Under a wiser policy the birds will be looked upon as domestic animals, engaged in a useful labor, and from which a greater benefit will be derived the more an intelligent consideration is shown for their welfare. By the protective measures there are three ends to gain.

1. The present number of birds may be permitted to spend a greater proportion of their time upon their chosen nesting-grounds so that a greater proportion of the guano may be available. The most useful birds, the "guanay" (*Phalacrocorax bougainvillei* Less, a cormorant) and the "alcatras" (*Pelecanus Molinae* Gr., a pelican) spend a great part of their time during the entire year upon the nesting-field or neighboring grounds unless frightened away by the presence of men. In this case they are likely to spend much more time upon the water, or upon the small islets and cliffs, where the deposits are less available, if not largely lost.

2. The present tendency to decrease in numbers may be checked. There is a wealth of reliable testimony from the older men of

long experience in the industry, that the useful birds, especially the alcatras, were formerly vastly more abundant than now. Considering the well-known facts regarding the robbery of eggs on a large scale in past years, the destruction of young and old birds, and the disturbance of the birds in their nesting-grounds by the extraction of guano, it is inconceivable indeed that the birds have not decreased greatly in numbers. If they have endured the treatment they have received without decrease in numbers, then protection can hardly be worth while. On the other hand, if it is true, as represented by every one who should know, that there has been a great diminution in number of birds, then—

3. *We may hope that the protection of the birds will result in a great increase in their numbers.* Before the working for guano on a large scale began and before the nesting-grounds began to be plundered for eggs and fowls, the birds must have existed in a condition of abundance dependent upon their food supply, their enemies and their natural prolificness. New factors have entered in recent years which have caused the birds to decrease materially below this *normal condition of abundance.* If these unfavorable factors are removed by well-considered and well-executed protective measures, why may we not see an increase in number toward the former normal abundance?

I think it conservative to say that the proper protection of the birds means the saving to Peru of hundreds of thousands of dollars' worth of guano each year. The wise action of the government in keeping closed during last season the south island of the Chinchas probably saved one thousand tons or more of guano of high grade during this year. Besides, it has been a benefit to the birds, which, if properly followed up, will yield results in all successive years. The keeping closed of the north island of the Chinchas would not have saved much guano during that season, but, as the beginning of a plan for the fostering of the alcatras, it might have yielded results in future years. For it seems sure that the alcatras was once an abundant and important bird in this region. Now it has practically abandoned the region, but as I showed in a report published in the *Boletin del Ministerio de Fomento* of June, 1907, the few alcatrases which remain had chosen this one island, of all in the Chincha and Ballestas groups, for their nesting-ground. The islands of Lobos de Afuera were abandoned for two years, and the alcatrases settled themselves chiefly in the northern part of the eastward island, and on an islet near by. Here, now, was an ideal arrangement: while the extraction of guano on a large scale was in operation in the Lobos de Tierra Islands, these timid birds were in undisturbed possession of the Lobos de Afuera. Unfortunately, this condition was not permitted to continue, for last season the extraction of guano was resumed on these islands, and the birds were entirely routed. They have now taken new positions, more or less scattered, but with an especial aggregation on the northern part of the westward island. Now guano is again to be extracted from these islands and the pelicans will be routed again from their newly established homes. Is it not time to awaken to the fact that the alcatras is gradually disappearing?

The three instances cited above are adduced to illustrate this point; we need not merely look out for the next two years, but may well plan for protective measures that are intended to work progressively to the advantage of the industry for the next twenty years or more. We want to see many more birds in 1915 than are present in 1908, and more birds in 1920 than in 1915; and this will not be accomplished by routing the birds from their nesting-grounds as soon as they are fairly established.

II. ONE CONTRACTOR TO AN ISLAND

As illustrating the effect of admitting more than one concessionist to an island, let us take the Ballestas Islands, as worked in 1907, for example. As directed by the government, I visited these islands in May and June, and again at the end of July. In the last part of May the work of extraction had been in operation but a few weeks and practically no guano had been shipped, yet every inch of

nesting-ground on all three islands had been dug up and thrown into piles, while every bird had been routed. It was perfectly evident that the work of extraction had been carried on entirely without regard to the preservation of the useful birds. I do not mean by this that there was much wanton destruction of the birds, but that practically no consideration was given to the necessities of these fowls for the completing of the rearing of their young or for the mating and other preparations for the next season of reproduction. No inducement was offered to the birds to continue nesting upon the same islands. A little more forethought and system in the manner of working might have saved many tons of guano for the season which is now beginning.

Now, this reckless mode of treating the birds will be continued as long as more than one contractor is licensed to work on the same ground. It is easy to picture the beginning of the work. Two or more contractors have concessions for certain quantities of guano on the north island of the Ballestas. There is on the southwest corner of the island a deposit of several hundred tons of fresh guano. Naturally, this place is the goal of each concessionist. The first to arrive, or the strongest, as the case may be, devotes every effort to the digging up of this area of high-grade guano, since by the act of heaping it in piles his claim is established, and no other contractor has the right subsequently to touch these piles. *Of course, this area of new fresh guano is the chosen breeding-ground of the birds, and so the entire flock of birds, young and old, is routed unceremoniously from the land of their recent nests.* As just the same policy is pursued simultaneously on each of the other two islands of the group, it results that *within the first few weeks of the open season every producing bird on the Ballestas Islands is driven from its nest.*

From the testimony of eye-witnesses it appears that a large number of young fowls were unprepared to abandon their nests, and that the enforced removal of the birds did not occur without the loss of an important number of helpless creatures. From personal observation I know that, even as late as the middle of June, there were large numbers of young birds on the south island of the Chinchas that were still being fed from mouth to mouth by the parents, and I must, therefore, believe that the complete routing of the birds from the Ballestas two months earlier, in April, must have been very harmful. We need not be too quick to blame the contractors in this case. Driven by the force of a very severe competition, they try to establish their claims immediately to as much as possible of the best guano, and, in the heat and bitterness of the competition, they grasp for guano while they are blinded to the welfare of the birds.

If but a single concessionist is admitted to an island, then a more systematic method of extraction may be followed, and more consideration be given to the needs of the birds. It would be better still if only a single concessionist were admitted to the group. Furthermore, the government can require of the concessionist that an intelligent and competent man be put in charge of the work of extraction, who shall be held responsible for the fullest protection of the birds.

I may also refer to the fact that such a measure would eliminate those many and unfortunate disputes between contractors which, as is notorious, have been occurring in recent years on these islands and which reach to the point of threatened and even actual personal violence.

III. CLOSING ISLANDS FOR PERIODS OF YEARS

The plan of working all islands simultaneously condemns itself, and a system of proceeding from one island to the next as soon as the guano from the first is exhausted is little better than the plan of working all islands simultaneously. An improvement on this is the plan which has been suggested several times recently, of dividing the islands into two groups, the islands of one group to be worked one year while those of the other remain closed. This, however, on consideration, is seen to be inadequate, since the birds would thus be disturbed each year as they are

driven back and forth from the islands of one group to those of the other.

The merit of a system of rotation depends on leaving the birds unmolested for periods of years, the longer the period the better. For example, it would be an incalculable gain if the alcatrases, which are now using the westward island of the Lobos de Afuera, could be left undisturbed on their grounds for the next four or five years, say until the extraction of old guano from Lobos de Tierra is concluded. Then, in turn, the latter island would be left to the birds for another period of five years, whether the Lobos de Afuera was exhausted in one year or in four years. In other parts of the coast, according to the conditions, certain islands would be opened each year, but in accordance with a plan which would permit the birds to remain undisturbed for periods of years.

In stating that the main hope of the guano industry consists in leaving the fowls unmolested for periods of years, I speak from my own observations on the habits of the birds and on the disturbing effect caused by the presence of even a single visitor. At the same time, it is not a new idea, and the intelligent men of long experience in the industry will insist upon the same principle. I wish to add this: the idea of a systematic closure of islands, if adopted, must be followed resolutely. It may sometimes mean the suffering of national agriculture or of the export trade for want of necessary fertilizer, but the suffering should be accepted rather than break the protective measures. It is fair to choose between two courses, either to plan for the future of the guano industry, adhering to reasonable protective measures, even if present sacrifice is necessary in order to reap the future benefit, or else, continually to cater to present wants and caprices and let the future look out for itself.

IV. CLOSED SEASON

It was a most wise action of the government in establishing a closed season of five months (November to March), when all of the islands were worked each year. Too much dependence, however, can be placed upon this measure. With a proper system of rotation and closure of islands for years, the closed season for the summer months becomes a matter of secondary importance. There is no season of the year when the birds may be disturbed without harm. In the middle of June last year there were numbers of birds in the Chinchas Islands which were still being fed from mouth to mouth by their parents. At the same time the process of pairing for the next season had begun and by July 29 hundreds of eggs had been laid, as the beginning of the next season's brood of young. During what months, then, could work have been conducted on this island without injurious molestation of the birds? The fostering of the birds will be accomplished only by leaving them unmolested for the entire year and for several years in succession. If an island is to be opened it is not of vital importance whether it be opened in April or in June.

I believe it to be more harmful to open too late than too early. To illustrate this, let us make an imaginary case of the south island of the Chinchas. If it be possible to do without this island, it will be most beneficial if the island may remain closed until April or May, 1909. Suppose that it is now decided to keep this island closed, and that later, about August, it is found that the supply of guano from other sources is inadequate and the demands of national agriculture are such that it is deemed necessary to extract guano from this island. The island is opened early in August—with what result? Just at the stage when the majority of the birds have mated for the season, when a large number of eggs are newly laid, and when the females are laden with eggs ready to be deposited in the prepared nests—just at this critical time, the birds are frightened from the island. The new-laid eggs are abandoned, and other eggs laid during this time of change may be lost as the birds chance to stop upon the neighboring rocks or islands. For the change of home is not accomplished in a day; it requires many days or weeks for the birds to realize that the old home must be abandoned, to settle themselves in a new place, and to recover from the demoralization attending the forced change.

More harm is wrought than if the birds had been routed in April; then, by the beginning of the new season of laying, they might have found themselves established in the new homes. The case is imaginary, but it leads to the following important conclusion: Before deciding whether to open or close the south island of the Chinchas, the Lobos de Afuera, the Zarate, the Isla Blanca, or any one of many large and small which have birds in reproduction, it should be carefully considered how much guano is required and from what places it may be obtained. The determination of which islands should remain closed and which open can then be made intelligently, and the islands opened at once or else kept finally and absolutely closed.

It is hardly necessary to refer to the fact that the condition of the sea in the winter months is much more unfavorable for the extraction of guano than in April or May.

The closed season serves a most useful purpose, but for the future the dependence must be placed on closure for periods of years, and less emphasis may be laid on the matter of a month or two.

V. TO PLACE THE EXTRACTION OF GUANO FOR NATIONAL AGRICULTURE IN THE HANDS OF A SINGLE COMPANY

Such a measure as this I believe to be a part of the ultimate solution of the problem. Saying this, I have no reference to any special arrangements which may be pending and with the terms of which I am unfamiliar. In making arrangements with a company, many subsidiary problems arise, such as, the effective protection of the birds, the proper system of rotation of the islands, the manner of conducting the work, the proper distribution of the guano in case the supply does not equal the demand, the analysis of the guano, and the selling by units of nitrogen and of phosphoric acid, the guarantee of an equitable price, etc. Undoubtedly these problems will be carefully studied out before any permanent contract with a company is entered into.

The merit of placing the guano extraction in the hands of a company depends upon making the contract last for a period of years, say for ten years or more. By this means the company is induced to *plan for the future,* which is the desideratum.

It is likewise very desirable that some adjustment may be made with The Peruvian Corporation Limited, with entire regard to all natural obligations, but with a view to securing a harmonious plan of working for the protection of the birds, and also to enabling the national agriculture to get the best of the guano, at a reasonable cost, and with prices proportional to the value of the guano. It is difficult to believe that two companies working in rivalry for the same guano will not work to the injury of the birds, unless each be strictly limited as to territory, or some way be found of harmonizing the rival interests for the benefit of the industry.

There are other important questions which need not be discussed here, but which should be suggested for consideration. A government bureau for the analysis of guano might be established in order to give to the small agriculturist the same advantage which the larger haciendas now enjoy, namely, of buying the guano by analysis. I have known cases of the adulteration of guano by sand, for the simple reason that the guano so reduced in quality could be sold by the contractor at the same price as a guano of higher grade. The price to all farmers, large or small, should be directly proportional to the value of the guano in the fertilizing elements as shown by analysis. The matter of having deposits of guano on shore has sometimes been suggested. This might serve to expedite the extraction of guano on the islands, so that they could earlier be abandoned to the birds, even if the fertilizer could not be sold and delivered at once. The shore deposits might be utilized to equalize the annual supply, and they might serve as the basis for mixing stations, should this prove practicable, where guanos of any desired strength of phosphoric acid and nitrogen could be prepared and supplied according to order.

CONCLUSION

It is seen, then, that there are many questions which require to be carefully studied

out. If the best solution is not attainable, then the second best may be adopted, but it may be the earnest hope of all that, after the fullest consideration of the matter, all parties interested may be led to cooperate in the attainment of a plan by which the interests of national agriculture may be safeguarded without the sacrifice of any legitimate interest.

The problem before the government, the national agriculture, and the exporting company, is this: How can the guano industry be saved to the future? Certainly no legitimate interest can be furthered by a continuance of the present unsatisfactory system, with its sacrifice of the birds.

I think the solution of the problem will be furthered if we put the question in this way: What system of regulation will result in the greatest annual deposit of guano twenty years hence?

NOTE

Without attempting at this time precise figures, the following considerations are suggestive and not misleading.

If we take a cubic meter of guano as a ton, then, with an average thickness of 10 cm. (4 inches), an area 10 meters by 10 meters, or 100 square meters, would yield ten tons of guano, and on 60,000 square meters there would be 6,000 tons. A point of significance, economically speaking, is the commercial value of permitting the birds to make the deposit even one centimeter thicker during the year. The flock of cormorants, *Phalacrocorax bougainvillei,* which covered very closely an area of 60,000 square meters (15 acres) and was the largest single aggregation of birds on the coast of Peru, was seen on the south Chincha island last year. It is easy to find that the nests average about three to the square meter, giving a total of about 180,000 nests. Allowing four birds to the nest, that is, a pair of adults and a pair of young, we have 720,000 birds. Two months later I estimated the flock as fifty per cent. larger, the island being at that time, in fact, practically entirely and densely covered with birds. It is not extravagant, then, to say that there were at least one million birds. Of course, very much smaller flocks are commonly estimated at "millions." Nor, again, does it seem out of reason to say that, had this island been opened by the government for extraction of guano, each month that the work endured would have caused the loss from this island of nearly 1,000 tons of guano, a part of which quantity, it is true, would have been deposited on other islands, but a large part of which would doubtless have been irrevocably lost. However, the main point to bear in mind, both from the point of view of the economist and from that of the naturalist, is this—that the continual disturbance of the birds means inevitably their gradual extermination.

Robert E. Coker

Lima, Peru,
April 8, 1908

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 651st meeting was held on May 23, 1908, President Bauer presiding. By invitation, Professor Bailey Willis, of the U. S. Geological Survey, presented and explained the proposal of the Washington Academy of Sciences to establish a weekly *Journal of Science.* The character and scope of the proposed publication were described at some length. The academy is to bear the entire cost of maintaining the *Journal* for the first three years and during this time the members of the affiliated societies are to receive the publication free of cost. In return for this service during the three years' experimental stage of the *Journal* the academy asks that the affiliated societies shall give the *Journal* their programs to print and for which they shall pay. Short abstracts of the papers read before the societies are to be submitted to the society for publication. At the close of the three years' experimental period it is proposed that the *Journal* shall thereafter be paid for by the affiliated societies at the rate of two dollars per member per annum.

Mr. R. L. Faris read a paper on "Tides in the Solid Earth observed by Dr. Hecker," being a review of the results of the horizontal pendulum observations recently published by Dr. Hecker at Potsdam. This paper will be published in full in the May, 1908, number of the *Monthly Weather Review.*

R. L. Faris,
Secretary